PATENT SPECIFICATION (11) 1 447 282

1 447 282

(21) Application No. 44687/73 (22) Filed 24 Sept. 1973 (19)
(31) Convention Application No. 7 213 021 (32) Filed 27 Sept. 1972 in
(33) Netherlands (NL)
(44) Complete Specification published 25 Aug. 1976
(51) INT. CL.[2] F01P 11/12 F28F 1/12
(52) Index at acceptance
F4S 42B 42M
B1T 399 54X 575 606 642 661 66Y 699 785 789
F4H G17

(54) COOLING SYSTEM

(71) We, N.V. PHILIPS' GLOEILAMPENFABRIEKEN, a limited liability Company, organized and established under the laws of the Kingdom of the Netherlands, of Emmasingel 29, Eindhoven, Holland, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The invention relates to a cooling system for a combustion engine, comprising a radiator which comprises a plurality of spaced parallel tubes for the passage of a cooling medium, the tubes being arranged substantially in one plane and communicating at one end with an inlet chamber and at the other end with an outlet chamber for the cooling medium, and the spaces between the tubes being spanned by metal heat-transfer fins which are in heat-conducting contact with the tubes and which are spaced longitudinally of the tubes so that air passages are formed between the fins and tubes.

Cooling systems comprising a radiator of this construction are known and have the drawback of being rather bulky. This hampers their installation in motor-cars, for example; also the material costs are substantial due to the heavy weight of the radiators.

According to the invention there is provided a cooling system for a combustion engine, comprising a radiator which comprises a plurality of spaced parallel tubes for the passage of a cooling medium, the tubes being arranged substantially in one plane and communicating at one end with an inlet chamber and at the other end with an outlet chamber for the cooling medium, and the spaces between the tubes being spanned by metal heat-transfer fins which are in heat-conducting contact with the tubes and which are spaced longitudinally of the tubes so that air passages are formed between the fins and tubes, wherein the hydraulic diameter of each of these air passages is less than 2 mm, the length of each passage is less than 25 mm, and the ratio $\frac{l}{d_h}$ is less than 25, l being the length and d_h the hydraulic diameter of each of the air passages, and wherein a dirt collector comprising an air-permeable screen formed with zigzag folds is arranged in front of the radiator so that air entering the radiator when the radiator is in use first passes through the screen, the latter having air passages with a hydraulic diameter of less than 2 mm.

The hydraulic diameter of an air passage is equal to four times the area of the cross-section of the passage divided by the length of the perimeter of the cross-section.

The fine structure of the air passages of the radiator due to their hydraulic diameter being less than 2 mm and their length less than 25 mm results in a substantial increase of the heat-transfer capacity per unit of front surface area of the radiator. This means that the front surface area and the overall weight can be much smaller and lighter, respectively, than in a conventional radiator.

However, due to the fine structure of the air passages, dirt particles present in the air entering the radiator can no longer pass through the radiator and tend to accummulate on the front surface, thus blocking the radiator or part thereof. To counteract this a dirt collector is arranged in front of the radiator in the cooling system according to the invention. This dirt collector consists of an air-permeable screen having air passages with a hydraulic diameter of less than 2 mm. This screen is formed with zigzag folds with the result that a number of parallel troughs of V-shaped cross-section are produced in the screen. The dirt particles present in the air now slide along the flanks of the troughs and collect at the back of the troughs, where they can be readily removed from time to time. The air from which the dirt particles have thus been removed passes

through the screen without substantial frictional loss and subsequently flows through the radiator which now remains clean.

A plurality of tubes for the passage of a cooling medium may be attached to the screen in a heat-conductive manner, the tubes communicating at one end with a common inlet chamber and at the other end with a common outlet chamber. The dirt collector can then serve additionally as the condensor of an air-conditioning system provided in, for example, a car.

A cooling system according to an embodiment of the invention will be described in detail with reference to the accompanying diagrammatic drawings, in which.

Figures 1 and 2 are a rear elevation and a sectional plan view, respectively of the cooling system, Figure 2 being taken on the line II—II of Figure 1, and

Figure 3 is a view similar to Figure 2 showing the same cooling system but with the dirt collector constructed to serve additionally as the condenser for an air-conditioning system.

The cooling system shown in Figures 1 and 2 comprises a radiator 1 which consists of a plurality of spaced parallel tubes 2 for the passage of a cooling medium. The tubes 2 are arranged substantially in one plane and the spaces between them are spanned by heat-transfer fins. These are formed by thin metal strips 3 and are connected in a heat-conductive manner to the tubes. The fins are spaced longitudinally of the tubes so that air passages 10 are formed between the fins and tubes. The tubes 2 communicate at one end with a common inlet chamber 4 and at the other end with a common outlet chamber 5.

The spacing between the metal strips 3 and the width of the strips are such that the hydraulic diameter of each of the air passages 10 is less thtn 2 mm, the length of each passage, which is equal to the width of the strips 3, is less than 25 mm, and the ratio $\frac{l}{d_h}$ is less than 25, l being the length and d_h the hydraulic diameter of the air passages. In a practical example the hydraulic diameter of the air passages 10 was 0.85 mm and the width of the strips 3 was 4 mm. As a result of this very small width, the tubes 2, which have a given cross-sectional area to permit a desired rate of flow of cooling medium through the tubes, project beyond the rear edges of the strips 3. In order to ensure that the narrow air passages 10 do not quickly become blocked by dirt particles present in the air entering the radiator, a dirt collector 6 is arranged in front of the radiator. This dirt collector consists of a very thin gauze screen 7 which is formed with zigzag folds so that a number of parallel troughs of V-shaped cross-section are produced in the screen. The mesh size of the gauze screen 7 is so selected that the hydraulic diameter of the air passages formed by the mesh openings is less than 2 mm. As a result of this fine structure of the screen, dirt particles present in the air cannot pass through the screen 7 and will slide along the flanks of the troughs to collect at the areas 8. The collected dirt particles can be removed from time to time from these areas, for example, by spraying with a water jet. The dirt particles are thus prevented from reaching the radiator 1.

The following example will demonstrate that the fine structure of the air passages 10 of the radiator 1 has a major influence on the heat-transfer capacity per unit of front surface area of the radiator and also on the weight of the radiator. If by reducing the spacing between the strips 3 the hydraulic diameter of the air passages 10 is reduced from 4 mm to 2.55 mm, whilst the width of the strips and therefore the length of the air passages remains unchanged, the heat-transfer capacity per unit of front surface area of the radiator is increased by a factor 1.3. If the quantity of heat to be transferred remains the same, the required front surface area of the radiator is thus reduced by a factor 1.3. However, the weight of the radiator has now been increased by a factor 1.15 due to the increased number of strips 3.

However, it was also found that the heat-transfer capacity of a radiator can be kept constant as long as $\frac{l}{d_h}$ remains constant. Consequently, by reducing d_h by a factor x, l can be reduced by a factor x^2. In practice, $x=3$ can be used. The hydraulic diameter of the air passages 10 will then be reduced from 2.55 mm to 0.85 mm, and the width of the strip 3, which would normally be approximately 40 mm, is reduced to approximately 4 mm. A radiator is thus obtained which combines an increase of the heat-transfer capacity by a factor 1.3 with, due to the reduction of the width of the strips, a reduction of weight by a factor 3.6. The value of the latter factor is a matter of calculation and is influenced by the number and material of the strips 3. Particularly the weight reduction is important in view of the resulting saving in material and the consequent reduction in the cost price of the radiator. Due to the increased heat-transfer capacity, installing the radiator in a motor-vehicle can be more readily effected.

It can be seen from the foregoing that the finer structure of the air passages of the radiator offers major advantages. Ob-

struction of these air passages by dirt particles is counteracted by the dirt collector 6.

This dirt collector can be constructed to serve additionally as a heat exchanger, shown in Figure 3, by soldering tubes 9 for the passage of a cooling medium to the gauze screen 7 and connecting these tubes at one end to a common inlet chamber (not shown) and at the other end to a common outlet chamber (not shown).

The tubes 9 can form part of an air-conditioning system such as is fitted in some types of cars. The dirt collector then also serves as the condenser in the air-conditioning system.

WHAT WE CLAIM IS:—

1. A cooling system for a combustion engine, comprising a radiator which comprises a plurality of spaced parallel tubes for the passage of a cooling medium, the tubes being arranged substantially in one plane and communicating at one end with an inlet chamber and at the other end with an outlet chamber for the cooling medium, and the spaces between the tubes being spanned by metal heat-transfer fins which are in heat-conducting contact with the tubes and which are spaced longitudinally of the tubes so that air passages are formed between the fins and tubes, wherein the hydraulic diameter of each of these air passages is less than 2 mm, the length of each passage is less than 25 mm, and the ratio $\frac{l}{d_h}$ is less than 25, l being the length and d_h the hydraulic diameter of each of the air passages, and wherein a dirt collector comprising an air-permeable screen formed with zigzag folds is arranged in front of the radiator so that air entering the radiator when the radiator is in use first passes through the screen, the latter having air passages with a hydraulic diameter of less than 2 mm.

2. A cooling system as claimed in Claim 1, wherein a plurality of tubes for the passage of a cooling medium is attached in a heat-conductive manner to said screen the tubes communicating at one end with a common inlet chamber and at the other end with a common outlet chamber.

3. A cooling system, substantially as herein described with reference to the accompanying drawings.

C. A. CLARK,
Chartered Patent Agent,
Century House,
Shaftesbury Avenue,
London, W.C.2.
Agent for the Applicants.

Printed for Her Majesty's Stationery Office by Burgess & Son (Abingdon), Ltd.—1976
Published at The Patent Office, 25 Southampton Buildings, London, WC2A 1AY
from which copies may be obtained.

1447282 COMPLETE SPECIFICATION

1 SHEET *This drawing is a reproduction of the Original on a reduced scale*

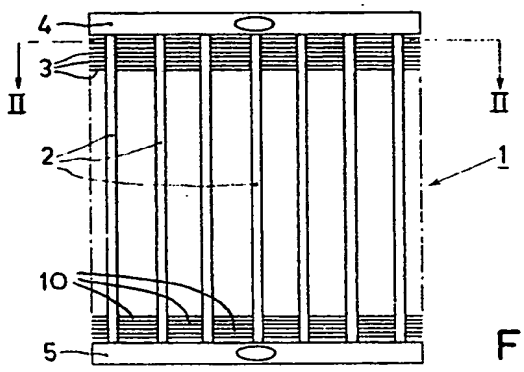

Fig.1

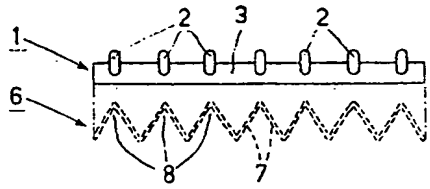

Fig.2

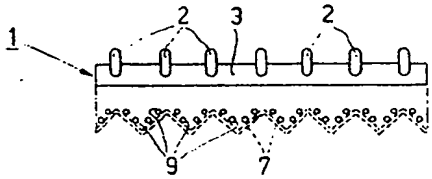

Fig.3